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Q&A on Electrostatic Discharge

PROVIDED BY THE ESD ASSOCIATION

Q: We are not permitted to bring our jackets, plastic sheet protectors, or plastic foam cups into the work area. We're told it's an ESD problem, but we thought ESD damage was caused by a discharge from the human body. What gives?

A: There are a number of sources of ESD. A discharge from the human body is just one of them and is represented as the human body model (HBM).

Another source of ESD is described by the term *field induction*. Whenever any object becomes electrostatically charged, there is an electrostatic field associated with that charge. This field may extend as far as a foot from the object. You can feel this field when you hold your hand in front of your television screen. When an ESDS device is placed in that electrostatic field, a charge may be induced on the device.

If the device is then grounded momentarily while within the electrostatic field, a transfer of charge from the device can occur (i.e., a charged device model discharge). The device could become grounded by setting it on a work surface that is too conductive or by intentionally grounding it when testing the board.

Items such as sheet protectors, nylon jackets, and foam cups are high-charge generators. Their presence in the work area exposes products that are sensitive to static electricity to the electrostatic fields that may be present on these objects.

Another source of electrostatic fields in the workplace is the cathode-ray tube (CRT) screen on a computer monitor. Although the newer monitors have reduced the electrostatic fields emanating from them, older models can measure over 10,000 V. Checking the screen for fields should be done in both a power-on and a power-off condition. CRT screens may even induce a charge on a person if the individual is ungrounded.

The following are solutions to the problem: keep static-generating materials out of your work environment, use topical antistats on computer monitors, employ ionization techniques, and use shields over the monitor screens.

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Additional information may be obtained by contacting the ESD Association, 7900 Turin Rd., Bldg. 3, Ste. 2, Rome, NY 13440; phone: 315/339-6937; fax: 315/339-6793; Internet: <http://www.eosesd.org>; e-mail: eosesd@aol.com. ■



Static Electricity and People

NIELS JONASSEN (MR. STATIC)

The question of interactions between the phenomenon of static electricity and people can be looked at in two ways: how people cause static chargings and how they are affected by it. The first of these may not always be well understood, but is generally not controversial. The second, however, is the subject of much unsubstantiated speculation.

How People Cause Static

The best-known charging process created by people is that of walking across an insulated floor covering. At first glance, this process seems simple. The contact and friction between the shoe soles and the floor cause a charge separation for each step. This charge makes the voltage of the human body capacitance increase until the unavoidable leakage current balances the charging current.

But the charge is separated at the interface between the shoe sole and the floor covering, and the sole is insulating. So how does the charge get transferred from the underside of the sole to the person?

Maybe it doesn't—maybe the person does not in fact achieve a net charge. All we see, in that case, is the effect of the induction caused by the charge on the sole. Mind you, this effect might well raise the person's voltage to substantial levels, with the net charge remaining zero. Or there may be leakage around the edges of the sole, or even a combination of these processes.

Oddly enough, nobody has ever really looked into this problem. And when you pose it to people presenting papers on the topic, they tend to become fidgety.

Another common way people can charge themselves is by removing an item of clothing. When a sweater is rubbing against a blouse, charges may be separated, but the voltage of the person will not increase, since equally large opposite charges are in principle located on the person. But when the sweater is removed, with, for example, a negative charge, the positive charge from the blouse provides a positive voltage.

Incidentally, the little zap you might feel at your ear when removing the sweater is not a sign of charging. Quite the contrary: it's a discharge (and it's not a spark, but a brush discharge). Sliding out of a car seat produces a similar charging process, and the slight shock you may feel is caused by you discharging to the car (and in this case with a *spark*), not by the car being charged. The latter process came to an end in the 1930s with the introduction of conductive rubber in tires.

How Static Electricity Affects People

Electrical Shocks. The best known effect of static on people, and the only proven effect in the opinion of many scientists, is that of the shock from a spark discharge. This usually occurs when a charged person touches a grounded object, or comes into contact with another

person who is at a different potential. Although this phenomenon is well known, there are no well-defined ranges for what level of body voltage will result in discharges that can be felt.

Few people, however, will notice discharges at voltages lower than about 1000 V. Most people will start to feel an unpleasant effect around 2000 V. Almost everyone will complain when exposed to discharges at voltages above 3000 V.

How high can body voltage be from walking on an insulating floor with insulating shoes? Certainly voltages in the range of 10–20 kV have been encountered under certain conditions, but in my opinion, the sometimes-quoted maximum value of about 35 kV is apocryphal. Long before that kind of voltage is reached, corona discharges would probably occur from the nose, ears, and other protrusions.

It is interesting to note that the question of whether the discharge of a conductor to a human body might have beneficial effects was once a serious question. In the 18th century, electrotherapy was widely used. In one application, capacitors, known as Leyden jars, were charged to voltages in the tens of kilovolts and discharged to paralyzed limbs. The resulting jerk was interpreted as a sign of a positive effect.

In most cases, however, the effects of static electricity on human beings have been considered harmful, or at least unwanted. In the age of the sick-building

syndrome, it was almost unavoidable that some of the many unspecific effects of an imperfect indoor climate should be attributed to the exotic phenomenon of static electricity. Static charging has sometimes been the suspected cause of headaches, dry mucosa, itchy skin, and other similar ailments. Rarely in such cases has any possible mechanism or explanation been suggested that was based on well-documented studies.

Plating Out. There is, however, one physical effect of static electricity that has some likelihood of causing physiological or hygienic problems: the effect an electric field around a person has on airborne particulates.

If a person is positively charged, he or she will attract negatively charged particles from the air. Or, as a physicist might prefer to phrase it, the field around the body will enhance the plateout of negatively charged particles onto the clothes and exposed skin. But neutral particles

will also be attracted, because they will be polarized, and because the fields, in general, will always be inhomogeneous. The field around a person may, as explained above, originate from charges being sep-

It has often been claimed that an excess or deficit of ions has a direct effect on human beings.

arated by walking on an insulated floor covering. But it may also be caused by proximity to a television or computer monitor.

Interestingly, if no one is close to a television or computer screen, the field will move toward the screen. Consequently, this is where particles will plate out, with resultant smudging. When a person is close to the screen, however, the field will also converge on that person's face, especially around protrusions such as the nose and ears.

Several scientific projects have demonstrated that electric fields around a person dramatically increase the plateout rate of airborne particulates. It has been suggested that if such particulates are of an allergenic nature, the plateout might result in an increased occurrence of skin irritation or disease. Such a relation, however, has not been demonstrated.

Are Ions Good for You?

A somewhat similar process is the effect on atmospheric ions of an electric field around a person (for a definition and description of the physical properties of at-

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ospheric ions, see my column in the May/June 1999 issue of *Compliance Engineering*, page 24).

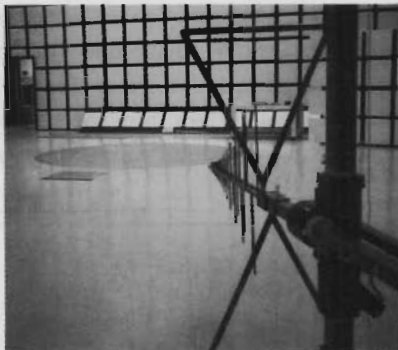
It has often been claimed that an excess or deficit of one of the polarities of ions in the air inhaled has a direct effect on human beings. Decades ago, one such claim was that an excess of negative ions would increase the vibration frequency of the cilia in the respiratory tract, thereby improving the cleaning efficiency of the cilia in the upper respiratory region. This theory was apparently supported by experimental results in the 1940s and 1950s and was widely quoted. About 1970, however, it was put to rest—or at least it should have been—because new investigations with more up-to-date instrumentation demonstrated conclusively that there was no such effect. Nevertheless, you may still find the ion-cilia relation cited in medical and quasi-medical publications.

An even more popular claim is that an excess of negative ions makes the air feel fresh and clean, while an excess of positive ions makes the air feel stuffy. Since this kind of vague effect is extremely difficult to prove or disprove, let it suffice to observe that the stuffy air under a thunder cloud has an excess of negative ions, while the fresh air on a mountain top is rich in positive ions. Thus there seems to be more to air quality than ion balance.

But let us nevertheless assume that the relative concentration of positive and negative ions in the air we breathe has an influence on our health. It is then clear that a person who is surrounded by an electric field (because he or she is charged) will inhale fewer ions than an uncharged person. If this person is positively charged, he or she will repel positive ions. Although the body will attract negative ions, the ions will be deflected to the skin and thus be removed from the inhaled air. And even if the person is not charged, most of the ions in the air inhaled will probably plate out in the airways before they even reach the bronchi.

The whole question about the fate of ions in the air we breathe still needs a lot of experimental work. It has been argued

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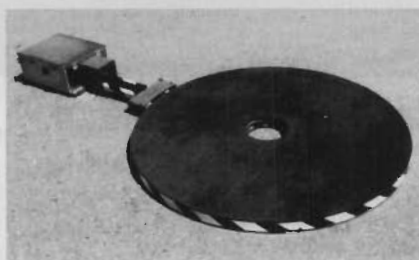
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that since a negative ion is likely to contain an oxygen molecule, inhaling negative ions must be a good thing. Beyond what I've noted about the plate-out on the skin and in the upper part of the airways, it should be pointed out that even in the highest possible ion concentrations there are trillions of uncharged oxygen molecules for each negative ion.

Over the last five to six years there have

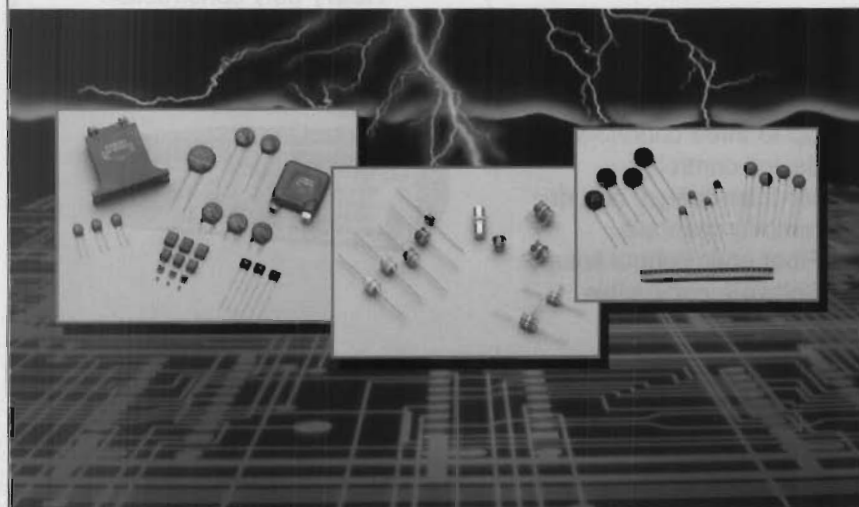
been many reports (at least in Europe) on the reputed benefits of exposing the skin of a person suffering from rheumatic or other ailments to a highly ionized airflow with ions of only one polarity.

In order for the person thus treated not to be charged, he or she must be connected to ground. The stream of ions will then cause a current from the point of impact to the ground connection. Ac-

cording to some of the reports, the effect of the treatment is highly dependent on where on the body the ground connection is placed. Of course, you can also create a current through the body simply by applying two or more electrodes, but doing so limits the path of the current to some degree.

If the ionized air does have an effect, it may be because the current originates from a larger area and thus has a greater

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The question of ions in the air still needs a lot of experimental work.

chance of finding the path with the largest effect. This also depends on the placing of the counter electrode or ground connection.

Please notice that I said *if* the ionized air has an effect.

The results that I keep hearing about are not from regular scientific investigations with double-blind tests and all that jazz. But they do keep coming, and I don't want to completely rule out the possibility that they are real.

I started working with ions in about 1958 to investigate some sensational claims from a national ion-guru in Denmark on the effects and behavior of ions in indoor air. I almost got crucified for requesting scientific documentation for the claims (such as that the air in a room with a vinyl floor had a bad ion balance). My above commentary on the possible effect of ionized air on the skin does not mean that I have mellowed over the years and relented in my requirements for documentation. Rather the contrary. I still love to play the role of St. Thomas the Doubter.

Niels Jonassen, MS, DSc, is retired from the Technical University of Denmark, where he has conducted classes on static electricity, ions, and indoor climate. He still runs his laboratory when he is not pursuing cooking classes in Thailand. ■